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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
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| 09/935,776 | 08/22/2001 | Charles M. Lieber | H00498.70054/TJO/DPM | 8935 |
| 23628 | 7590 | 09/15/2004 | EXAMINER | |
| WOLF GREENFIELD & SACKS, PC FEDERAL RESERVE PLAZA 600 ATLANTIC AVENUE BOSTON, MA 02210-2211 | | | HU, SHOUXIANG | |
| | | | ART UNIT | PAPER NUMBER |
| | | | 2811 | |

DATE MAILED: 09/15/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/935,776

Applicant(s)

LIEBER ET AL.

Examiner

Shouxiang Hu

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 04 March 2004.
- 2a) ☒ This action is FINAL. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-47, 49-73, 75, 76, 97-111, 113-201, 261 and 262 is/are pending in the application.
- 4a) Of the above claim(s) See Continuation Sheet is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) See Continuation Sheet is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date 3/4/04, 10/2/03, 9/11/03.
- 4) ☒ Interview Summary (PTO-413)
Paper No(s)/Mail Date. 20040818.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

1. In view of the previous office action and the 03-04-04 amendment, claims 1-47, 49-73, 75-76, 97-111, 113-201, 261-262 are pending in this application. Among them, claims 3, 4, 9-31, 49-55, 102-105, 109, 111, 113-116, 121-174, 176-180, 182, 184, 185, 190, 192, 193, 196-201, 261 and 262 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected invention; and, claims 1, 2, 5-8, 32-47, 56-73, 75, 76, 97-101, 106-108, 110, 117-120, 175, 181, 183, 186-189, 191, 194, and 195 remain active in this office action.

Claim Objections

2. Claims 1, 2, 5-8, 32-47, 43-47, 58-61, 73 and 183 are objected to because of the following informalities and/or defects:

Claim 1 and 73 each recite the term of "being free-standing"; but, in a device, none of the elements therein can be free-standing, although some of them may be free-standing during the process of making the nanowires.

Claims 43-47 and 58-61 each recite the subject matters regarding the length/diameter ratios of the semiconductors in a device that has at least four such semiconductors, but the original disclosure lacks an adequate description regarding what the length/diameter ratios should be in a device having four such nanowires.

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Claims 183 fails to clarify what are the relationship between the recited "at least one semiconductor" and the four semiconductors already defined in claim 110.

Appropriate correction is required.

Claim Rejections - 35 USC § 112

3. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 99-101 and 106-108, as being readable on applicant's elected species, are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Claims 99-101 and 106-108 recite the subject matter(s) of four bulk-doped semiconductor that exhibit coherent transport, no scattering, ballistic transport and/or Luttinger liquid behavior. However, the specification lacks an adequate description regarding how such four doped IV-IV semiconductor can still possess such recited characteristics, and how a material with such characteristics can still be used in the elected species involving at least one field effect transistor, and what kind of device/element can be formed with such four semiconductors.

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Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claims 1-2, 7, 32-47, 56-59, 70-73, 75, 76, 97-101, 106-108, 110, 117-120, 175, 181, 183, 186-189, 194 and 195, insofar as being in compliance with 35 U.S.C. 112, are rejected under 35 U.S.C. 103(a) as being unpatentable over Chung et al. ("Chung"; Applied Physics Letters, V76, N15, p2069-2070) in view of Miyazaki (US 5,537,075).

Chung discloses a device including a field effect transistor (see Fig. 1), comprising: a doped semiconductor (p-type doped single crystal silicon nanowire; having a diameter as small as 14 nm, and a length as long as 10 um, see the first column); and an exterior shell (oxide coating).

It is noted that, in the instant specification, the term of a "free standing" article is defined as meaning: an article that at some point in its life it is not attached to another article or that is in solution (see page 35, lines 1-2). Accordingly, the term of "free-standing" recited in the claims is hereby regarded as a process limitation, as all meaningful utilities found in the instant disclosure are at the non-free-standing state. The limitations of "free-standing" and "bulk-doped" recited in the claims are hereby treated as process limitations, and they would not carry patentable weight in the claims

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drawing to a structure, because distinct structure is not necessarily produced. In re Thorpe, 227 USPQ 964, 966 (Fed. Cir. 1985).

Chung does not expressly disclose the device can comprise more such semiconductors to form more such transistors. However, as evidenced in Miyazaki (see the circuit in Fig. 10), one of ordinary skill in the art would readily recognize that regular integrated circuit devices commonly comprise multiple individual transistors, from including several transistors in a logic unit or an amplifier unit to including millions of transistors in a processor.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to make a device of Chung with more than four transistors being integrated, as taught in Miyazaki, so that an integrated circuit device with desired functionalities would be obtained.

Regarding claim 7, a silicon semiconductor can be regarded as a Si-Si IV-IV semiconductor.

Regarding claims 40, 41, 70 and 71, it is noted that one of ordinary skill in the art would readily recognized that the diameter of a semiconductor nanowire can be desirably as small as less than 5 nm for further reducing the device size, as evidenced in the prior art such as Morales et al. (Science, V279, pages 208-211, which discloses a nanowire having a diameter of 3 nm).

Regarding claims 99-101 and 106-108, insofar as being in compliance with 35 U.S.C. 112, the Si nanowire in Chung naturally has the characteristics substantially

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same as that of the claimed invention, as they both have a material and dimension substantially the same to each other.

5. Claims 1, 2, 5-8, 32-47, 56-73, 75-76, 97-101, 106-108, 110, 117-120, 175, 181, 183, 186-189, 194 and 195, insofar as being in compliance with 35 U.S.C. 112, are rejected or further rejected under 35 U.S.C. 103(a) as being unpatentable over Morales et al. ("Morales"; Science, V279, pages 208-211) in view of Heath et al. ("Heath"; US 2001/0054709 A1), Tans et al. ("Tans"; Nature, V393, p49-52) and/or Miyazaki (US 5,537,075).

Morales discloses a semiconductor (a nanowire; single crystal Si or Ge; formed through a free-standing process; and with a diameter as small as 3 nm and a length up to 30 μm), and an exterior shell (silicon oxide). Morales further discloses that the semiconductor can also be formed with SiC).

Although Morales does not expressly disclose that the semiconductor can be doped to become either p-type or n-type and that more than four such semiconductors can be included in a device, one of ordinary skill in the art would readily recognize that a semiconductor normally has to be doped to become one the two types for forming various functional semiconductor devices, as evidenced in Heath, which teaches to form a doped semiconductor nanowire (through a bulk-doping process, see section 0042 and 0045); that a field effect transistor can be desirably formed with a semiconductor nanowire for reducing the device size, as evidenced in the prior art such as Tans et al.

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(see Figs. 1-3); and, that an integrated circuit commonly comprises more than four individual transistors, as evidenced in Miyazaki (see the transistors in Fig. 10).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to make an integrated circuit device with more than four transistors made from bulk-doped semiconductor nanowires of Morales in view of Health, per the teachings of Tans and/or Miyazaki, so that an integrated circuit device with desired functionalities and reduced size would be obtained.

Regarding claims 99-101 and 106-108, insofar as being in compliance with 35 U.S.C. 112, the nanowire collectively taught by Morales and Health would naturally have the characteristics substantially the same as that of the claimed invention, as they both have a material and dimension substantially the same to each other.

Response to Arguments

6. Applicant's arguments with respect to the rejected claims above have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

7. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

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A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Shouxiang Hu whose telephone number is 571-272-1654. The examiner can normally be reached on Monday through Thursday, 7:30 AM to 6:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Eddie C. Lee can be reached on 571-272-1732. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should

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you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

SH
September 11, 2004

A handwritten signature in black ink, appearing to read 'Shouxiang Hu', written in a cursive style.

SHOUXIANG HU
PRIMARY EXAMINER

Continuation of Disposition of Claims: Claims withdrawn from consideration are 3,4,9-31,49-55,102-105,109,111,113-116,121-174,176-180,182,184,185,190,192,193,196-201,261 and 262.

Continuation of Disposition of Claims: Claims rejected are 1,2,5-8,32-47,56-73,75,76,97-101,106-108,110,117-120,175,181,183,186-189,191,194 and 195.